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An analysis of research on metacognitive teaching strategies

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Abstract

Metacognition has been an area of interest to educational researchers for more than 40 years. A large body of literature exists on this topic, both theoretical and empirical. However, there are few studies that summarize specific instructional practices for improving students' capacity for metacognitive thinking. Similarly, there is a dearth of evidence showing how specific practices are implemented to affect student achievement. This review addresses gaps in these areas by identifying instructional approaches in the empirical literature that promote metacognitive thinking in primary and secondary student populations using analytical literature review methods.

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1. Introduction

In an earlier publication (Ellis, Bond, & Denton, 2012) we reviewed the empirical research literature related to the effects of metacognition instruction and practice on academic achievement in K-12 populations. Despite the fact that very few peer reviewed experimental and/or quasi-experimental studies exist, those we found do indeed suggest the efficacious nature of such instruction and practice. Increasingly, however, educational reformers have worked vigorously to integrate new accountability measures for teachers and students across the K-12 spectrum. One change brought about by these efforts is adoption of new teacher evaluation models, such as The Framework for Teaching (Danielson, 2011) and The Marzano Teacher Evaluation Scales (Marzano Research Laboratory, 2011). These models share a number of similarities, one of those being an emergent emphasis on teacher reflection. According to the Marzano Teacher Evaluation Scales, effective teachers reflect on and evaluate the effectiveness of their instructional performance and areas of pedagogical strengths and weaknesses. Similarly, The Framework for Teaching suggests that teachers reflect analytically on student learning to make adjustments, drawing on their repertoire of strategies for continuous improvement. This trend makes sense given that if students are expected to practice reflection regarding what they have been taught, then so should their models, that is, teachers engage in reflective practice.

The newer models used for evaluating teachers also include descriptions of student reflection as a means of showing comprehension of daily lesson objectives (Marzano Research Laboratory, 2011) and as a method of summary learning (Danielson, 2011). Additional representations of this phenomenon are found in the Common Core

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State Standards for English Language Arts (2010). In this document, the purpose of reflection serves finite, subject-specific uses, such as identifying evidence from informational text (p. 18), revising writing over time (p. 21), and developing detailed narrative (p. 43).

For teachers and students, characteristics of this form of reflection are both instrumental and objective. Reflection, as it is defined through these evaluative models, focuses heavily on self-assessment in to predefined performance criteria. Teachers reflect on their performance in comparison to established and detailed evaluation rubrics. Students reflect on their performance in comparison to measurable and standardized learning objectives. One model of instruction has euphemistically labeled this type of reflection as *student voice* (Teacher Performance Assessment, 2012), even though this label is inaccurate, since this form of reflection deemphasizes student autonomy, interest, and awareness (Brooker & MacDonald, 1999). Much of what is labeled “student voice” is other-directed, focused on standardized test achievement, and seldom subjected to opportunities for critical analysis and creative thought on the part of students. Certainly, most of the models touting teacher and student reflection are in fact dedicated to what Jurgen Habermas (1971) has called the technical interest, that is a narrow means-end pursuit supported by those who are convinced that standardized test scores are the best and most meaningful measure of school learning. Seldom do these models rise to the level of the practical interest, much less to the emancipatory interest in the name of reflection.

Defining reflection through the lens of metacognition provides a way to diverge from reform models which have integrated reflective practice and focused it on evaluation, performance, and objective responses. Bruner’s (1996, p. 88) description as a process of “making sense, going ‘meta,’ turning around on what one has learned through bare exposure, even thinking about one’s thinking,” is a place to begin. Flavell describes metacognition as a heightened awareness of one’s thought processes, that is, “knowledge concerning one’s own metacognitive processes or anything related to them” (1976, p. 232). Others, including Brown (1987), Barell (1991), Metcalfe and Shimamura (1994), and Zhang (2010), while basically accepting Flavell’s description, have expanded the term to encompass such cognitive activities as reflection, sentience, self-regulation, self-assessment, and even executive function.

The pedagogical promise and possibilities of metacognition suggest “value-added” strategies or techniques in the sense that students might do something more than attempt to solve problems and engage in learning; they might also reflect not only on *what* but on the *how and why* of what they have learned as a result of their experiences (Ellis, 2011; Ellis, Bond, & Denton, 2012; Krathwohl, 2002; Nuckles, Hubner, Dumer, & Renkl, 2010; Wilson & Smetana, 2011). This is in itself hardly a novel idea. The writings of Socrates and Confucius, to cite two examples from antiquity, underline the importance of the reflective life. This interest in metacognition has persisted across time. One result is the accretion of a substantial body of literature about metacognitive theory and metacognitive training, such as the meta-analytic research conducted by Dignath and Büttner (2008), and Hattie, Biggs, and Purdie (1996). Nevertheless, Pintrich (2002) writes that, “because metacognitive knowledge in general is positively linked to student learning [see Black & Wiliam, 1998; Gulikers, Bastiaens, Kirschner, & Kester, 2006; Michalsky, Mevarech, & Haibi, 2009], explicitly teaching metacognitive knowledge to facilitate its development is needed” (p. 224). However, the literature tends to describe methods for teaching metacognitive thinking in theoretical and general terms, with little discussion of specific practices, such as the kind called for by Pintrich.

1.1. Definitions

Metacognition is a concept of cognitive psychology that “focuses on the active participation of the individual in his or her thinking process” (Stewart & Landine, 1995, p. 17). A wide range of definitions and interpretations of the term metacognition have been accumulated (Manning & Payne, 1996) since it was first used by Flavell. Flavell’s expanded description (1979, p. 906) included knowledge of strategy, task, and one’s own cognition. These three related kinds of metacognitive knowledge continue to be perceived as essential components of the learning process (Krathwohl, 2002; Pintrich, 2002). Brief definitions of each follow.

1.1.1. Knowledge of strategy

Strategic knowledge refers to knowledge of strategies for learning and thinking (Pintrich, 2002). According to Pressley and Harris (1990), strategy is defined as a procedure for accomplishing an academic task. Alternatively, metacognitive strategies refer to a learners' knowledge of their own cognitive processes (Dignath & Büttner, 2008). An example of strategic knowledge is when a student uses a learning strategy, such as a "think aloud" or "I learned statement" as a reflective self-assessment tool.

1.1.2. Knowledge of task

Knowledge of tasks and their contexts includes different types of cognitive tasks as well as the classroom and culturally normative knowledge of the conditions under which these strategies might be used (Pintrich, 2002). Flavell (1979) suggests that "goals (or tasks) refer to the objectives of a cognitive enterprise" (pp. 906-907). In addition to their mastery of several types of strategies, students should acquire knowledge about how, when, why, and where to apply these strategies (Veenman, Van Hout-Wolters, & Afflerbach, 2006). An example of task knowledge is when a student consciously understands a lesson objective, activity, or procedure as explained by a teacher or due to a repeated classroom routine.

1.1.3. Knowledge of self

Knowledge of one's own cognition is a critically important component of metacognitive knowledge. "Metacognitive knowledge involves knowledge about cognition in general, as well as awareness of and knowledge about one's own cognition (Pintrich, 2002, p. 219). Ideally, when students are aware of their strengths and weakness as learners (knowledge of self), they are able to choose a learning strategy (knowledge of strategy) that is aligned with the task at hand (knowledge of task).

2. Summary

2.1 Features of the learning environment for teaching metacognitive strategies

Some empirical studies suggest that metacognitive strategy use is rare in comparison to traditional teaching approaches. For example, Kistner et al. (2010) found that German mathematics teachers spent little time instructing their students how to learn effectively. Similarly, Leutwyler (2009) suggested that traditional curricula and instructional practices are insufficient for promoting metacognitive thinking. Rather, elements such as explicit focus on learning processes or emphasis of deep understanding are necessary (Leutwyler). As a result, students tend not to use or refine their metacognitive strategies over time (Leutwyler). More often, the features necessary for fostering metacognitive learning seem to be absent during regular lessons, even though many of these features are associated with positive gains in achievement over time (Kistner et al.).

2.1.1. Engaging curriculum

One of the critical features of the learning environment for fostering metacognitive strategy use is an engaging curriculum (Leutwyler, 2009). A curriculum which integrates student interest, active learning, and collaboration affords frequent opportunities for students to use metacognitive thinking skills. Contrariwise, as Haidar and Al Naqabi (2008) suggest, traditional teaching practices do not encourage students to reflect on their thinking. For example, the characteristics of an engaging curriculum, such as constructivism, self-direction, and transfer are often used infrequently in comparison to more direct methods such as whole class instruction (Kistner et al., 2010). Nevertheless, adjusting a curriculum to be more engaging for students can have a substantial effect on the quality and quantity of metacognitive strategy use. Some general examples for making a curriculum more engaging include integrating student choice, problem-based learning, and concept teaching (Haidar & Al Naqabi; Leon-Guerrero, 2008; and Scharlach, 2008).

2.1.2. *Assessment integration*

As students move through each grade, their understanding of the school system improves. Brookhart (2001) defined this evolution as “studenting” which means that students figure out what the teacher expects of them and then they learn to do these activities well (p. 165). One way that students learn what the teacher wants is through assessments, such as tests and quizzes. Often, classroom assessments dictate the kind of skills and knowledge that students are expected to learn. An assessment can show convergent or divergent questions. Convergent questions require a specific answer, such as calculating the solution to a mathematics problem (Guilford, 2007). Alternatively, divergent questions are open-ended, for which there are many possible answers, such as questions dealing with moral dilemmas (Guilford).

Some researchers have suggested that education reform efforts have led to an over-emphasis of convergent questioning (Brown & Clift, 2010). Moreover, Leon-Guerrero (2008) stated that divergent questioning is a necessary characteristic of metacognitive strategy use so that students will reflect on and evaluate their performance. Similarly, since assessments focus student attention on important knowledge and skills, assessment questions that require the use of metacognitive strategies are necessary. For example, questions that emphasize self-checking or evaluation of one’s strengths and weaknesses (Haidar & Al Naqabi, 2008).

There is evidence to show that students will apply metacognitive strategies in an unbalanced way when assessments emphasize convergent thinking. For example, Haidar and Al Naqabi (2008) found that science students engaged in significant amounts of planning to solve stoichiometry problems. However, students did this in order to set up problems and apply algorithms. Students did not utilize any additional strategies that require monitoring or evaluating because such strategies were not perceived by students as being important for performing well on assessments.

2.1.3. *Consistent practice*

Although Kistner et al. (2010) found that strategy instruction does indeed take place in classrooms, they also reported that it was applied with wide variation, anywhere from 10 to 40 strategy instructions per lesson. Similarly, when strategies were taught, they were often cognitive in nature, and not metacognitive (Kistner et al.). For example, teachers often used strategies for elaborating, organizing, or repeating information (Kistner et al.; Leon-Guerrero, 2008). As a result, providing consistent practice opportunities is another feature for fostering metacognitive strategy use. Scharlach (2008) suggests teaching multiple metacognitive strategies, such as making predictions, visualizing, and summarizing. Scharlach also suggests that these strategies be used repeatedly across multiple lessons in order to produce tangible gains in student achievement. However, providing consistent practice opportunities must be accompanied by evaluation. For example, students should be prompted to judge the effectiveness of their learning method by considering past performance with respect to established goals (Leon-Guerrero).

2.1.4. *Explicit strategy instruction*

A factor closely related to providing consistent practice opportunities is the *method* used for instructing metacognitive strategies. Generally, teachers use implicit methods, rather than explicit (Kistner et al., 2010). For example, in an analysis of 60 lessons from 20 German mathematics teachers, Kistner et al. found that on average, teachers taught strategies through implicit instruction in comparison to explicit instruction at a ratio of 5 to 1. Instructing students implicitly on the use of a strategy means modelling it without explaining how the strategy is effective. Alternatively, modelling a strategy for students while simultaneously verbalizing one’s thought processes or asking targeted questions during the demonstration is a form of explicit strategy instruction. Explicit strategy instruction is positively correlated with achievement gains, while using an implicit method is less so (Kistner et al.).

Nevertheless, students can be trained to engage in metacognitive strategy use, such as proof reading work, even though they may not be entirely aware of the benefits (Haidar & Al Naqabi, 2008).

The most significant gains in student achievement result when students are taught the use of metacognitive strategies in explicit ways (Haidar & Al Naqabi, 2008; Kistner et al., 2010). Characteristics of explicit teaching include direct instruction, modelling, explaining the benefits of using the strategy, and providing repeated opportunities for using the strategy in guided and independent practice formats (Scharlach, 2008).

2.1.5 Verbalizing

A fifth factor is to accompany strategy modelling and strategy practice with verbalizations. Providing explanations as a part of strategy modelling promotes explicit strategy instruction (Scharlach, 2008). Likewise, students who conduct internalized self-talk, thinking aloud, or talking with a partner while they execute the steps of a strategy, show an improved ability to manage academic tasks (Haidar & Al Naqabi, 2008; Leon-Guerrero, 2008). Careful questioning also has a significant impact on how effectively students use metacognitive strategies (Leon-Guerrero). Posing thoughtful questions prompts students to select and use strategies, while also raising their awareness about how and why they are using them. Having students tell a partner about the steps they took to solve a problem, the reasons they chose a particular study method, or the effects of a strategy on performance are examples of verbalizing.

3. Discussion

In the empirical research reviewed modelling stood out as the most widely used approach to metacognitive training. Modelling involves showing students specific procedures to follow for using a strategy. It also involves explaining to students the usefulness of the strategy. Often, the studies describe the teacher modelling the strategy visually and through verbalization. For example, as teachers act as models, they also verbalize what they are doing, why they are doing it, and ways for overcoming obstacles. They also signal what they think is important by what they leave in and what they leave out of any given teaching/learning encounter. The consistent use of modelling supports claims made by Kistner et al. (2010) that effective strategy instruction be shown to students through explicit methods.

The second most common strategy found was diagramming. Similar to modelling, diagrams were used across all three metacognitive categories: planning, monitoring, and evaluating. Some researchers suggest that visual learning methods are more memorable (Medina, 2008) and engaging (Pressley & McCormick, 2007). The frequent use of diagrams, which resulted in positive achievement gains, supports these conclusions.

The third most common strategy was practice, both guided and independent. As in the case of modelling, researchers have suggested that consistent practice is one of the characteristics of effective metacognitive strategy instruction (Leon-Guerrero, 2008; Kistner et al., 2010).

Four additional strategies were reported, including mnemonics, answer checking, checklist, and goal attainment. However, mnemonics were used specifically for planning writing. Alternatively, answer checking, checklist, and goal attainment were used across two metacognitive categories.

3.1. Research to practice

A frequently used method for modelling metacognitive strategy use is *Think Aloud*. Think Aloud means verbalizing the steps or procedures of a strategy as it is being deployed. It also involves posing questions, identifying resources, and reciting affirmations. For example, a teacher might say the following while modelling a strategy for solving a one-step algebra equation, "The first step is to identify the unknown variable... there it is, x. Now I look to see if there is a coefficient greater than 1. Yes, the coefficient in this equation is 2. I can go to the next step."

Teachers can use an *I Learned Statement* to conclude *Think Aloud* modelling. I Learned Statements are spoken or written summaries of what has been learned after completing an academic task. In keeping with the algebra

example, a teacher might summarize her learning by saying or writing the following comment for students, “I learned how to divide all of the expressions in an equation by the coefficient to reduce it to one.” Think Aloud and I Learned Statements show a positive effect on achievement when they are used by teachers and students (Bond & Ellis, in press; Lan, 2005). When teachers model the use of Think Aloud or I Learned strategies as teaching devices designed to enable students to understand how they work, then of course, students can be encouraged or required to use them on their own (Ellis & Denton, 2010; Ellis & Evans, 2010).

Another method for implementing metacognitive strategy use is diagramming. There are a number of approaches for making academic diagrams, including concept maps, mind maps, geography maps, semantic webs, flow charts, and graphs. A flexible format for integrating diagrams as an instructional approach is *Learning Illustrated* (Ellis, 2010), where students create drawings to show their understanding of concepts, information, or procedures. For example, students could use a t-chart to identify sources of renewable and non-renewable energy in science class. Along with the results of this analytical review, there are a number of other sources showing that visual modes of learning have a significant impact on achievement (McBride & Doshier, 2002; Read & Barnsley, 1977; Stenberg, 2006).

Whether students speak, write, or illustrate their thinking, practice is a critical element. Effective practice is both guided and independent. Guided practice means that the teacher orchestrates student use of the strategy through examples, demonstrations, and feedback. Having students imitate the teacher’s use of the strategy is also appropriate when students are first exposed to the strategy. Independent practice is assigned once students demonstrate sufficient mastery. Whatever product students create as a result of independent practice also receives teacher feedback and is used to check student understanding.

For example, guided and independent practice for teaching students to write an introduction to an essay includes the following teacher and student activity: 1) the teacher demonstrates steps for writing by following a mnemonic while students observe; 2) students replicate the steps in-class with a subject different from the one used during demonstration; 3) the teacher circulates and observes student writing and provides feedback as students write; 4) students write a second introduction, on a new topic, independently; 5) the teacher provides feedback, and the process repeats.

Practice is essential for effective strategy use, but it is an insufficient condition for integrating metacognitive thinking. Students need opportunities to make sense of their learning. A useful method for doing this is summarization. Creating a summary means distilling information into a synthesized form by showing main points with supporting details through deletion, substitution, and reorganization. Summarizing, along with note-taking which is a form of summary, has shown a positive effect on student achievement (Marzano, Pickering, & Pollock, 2001). A practical format for summarizing is *The Week in Review* (Ellis, 2010). For this activity, students summarize what they have learned over the course of a week. The summary can be constructed independently or collaboratively and then shared in class. The contents of *The Week in Review* also serve as an informal check of student learning as well as a bridge to connect current subject matter with upcoming subject matter.

Teachers can have students summarize in divergent ways, such as compiling lists of I Learned Statements after a week of instruction. Alternatively, summaries can be convergent, such as structured note-taking. There are two additional instructional practices, derived from the literature analysed in this review, that tend to prompt convergent outcomes, including answer checking and checklists.

Answer checking occurs when students generate responses and compare them to pre-established solutions, such as those found on an answer key. Like practice activities, answer checking that fosters metacognitive thinking is more effective when accompanied by specific self-monitoring questions, such as “Why is my answer different in comparison to the answer key?” or, “What steps did I take to get this answer?”

Checklists are similar to answer checking since they involve making comparisons. However, the purpose of a checklist is to prompt specific behaviours by having students identify complete or incomplete activities. To revisit the example of having students write an introduction to an essay, the teacher may use a mnemonic, such as SIPPS: select an approach, interest the reader, present the main idea, provide background information, and signal what is ahead. In this example, the mnemonic works both as a reminder and checklist for including specific elements.

The requirement that students complete a checklist, such as filling in a box, circling *yes – no*, or placing a check, increases the likelihood of complying with the expected behaviour or performing the task.

The final method under examination in this review is goal attainment, which is also positively associated with student achievement (Marzano, 2009). An important characteristic of goal attainment is analysis of past performance, such as using scores from previous writing tasks to set new performance goals (Brunstein & Glaser, 2011). For example, students colour-in squares on a performance graph indicating that they have achieved specific writing goals (Tracy, Reid, & Graham, 2009). Another method for combining goal attainment and analysis of past performance is *Record Keeping* (Ellis, 2010). Procedures for Record Keeping include having students evaluate their own performance data over time, such as graphing the number of push-ups performed in physical education, scores earned on quizzes in history class, or keeping track of time spent studying and doing homework.

4. Conclusion

4.1. Practices that foster metacognitive strategy use

Five environmental features were identified that enhance the effectiveness of metacognitive strategies. While these do not describe specific practices, they do suggest necessary conditions for effective metacognitive training. These factors include engaging curriculum, assessment integration, consistent practice, explicit strategy instruction, and verbalizing. Interestingly, it was also found that use of metacognitive strategies was less common in comparison to traditional teaching approaches, at least from the studies analysed in this review, which were investigating metacognitive interventions (Kistner et al., 2010; Leutwyler, 2009).

4.1.1. Planning, monitoring, and evaluating thinking

Eight studies which met the criteria we established were analysed to determine the extents to which instructional methods that promote metacognitive thinking are successful. Three categories of instructional strategies were identified—planning, monitoring, and evaluating thinking. Planning strategies included modelling, goal attainment, checklists, diagrams, mnemonics, graphic organizers, and guided practice. An average effect size of the three studies reviewed (Brunstein & Glaser, 2011; Fidalgo, Torrance, & Garcia, 2008; Tracy et al., 2009) for metacognitive planning was .62. Among the monitoring strategies identified in the analysis were modelling, diagramming, answer checking, and practicing. The average effect size was .91 for monitoring (Boulaware-Gooden, Carreker, Thornhill, & Joshi, 2007; Huff & Nietfeld, 2009; Reynolds & Perin, 2009). Finally, strategies for evaluating thinking included modelling, independent practice, self-testing, and answer checking. An average effect size for evaluating was .71 (Ramdass & Zimmerman, 2008; Zirkle & Ellis, 2010). Such effect sizes are impressive, but the question whether they might hold up under the bright light of replication needs to be addressed before one jumps to conclusions regarding the effects of reflective practice. Still, the preliminary results are most encouraging. It seems only reasonable to conclude that these large effect sizes emanating from a limited number of qualifying studies suggests the need for replication and further study in order to make more definitive claims. And finally, it is well to keep in mind that these are strategies for looking back on experiences in teaching and learning. The strategies themselves, while seemingly helpful, are captives of the quality of the experience.

4.1.2. Examples of effective practice

According to the research analysed in this review, metacognitive strategies are applicable across different disciplines and grade levels and they are effective for teaching both content knowledge and academic skills. Instructional practices most frequently used included teacher modelling with Think Aloud, diagramming, practice, answer checking, checklists, and goal attainment.

4.2. Closing remarks

Schools and classrooms are complex seemingly refractory places where a multitude of variables interact, often with confounding results. To ask students to reflect on their learning is to open Pandora's Box. Who knows what will fly out once the lid is pried? To what extent are classrooms typically places where students are given voice not merely to think about how well they have learned an assignment but also to express their ideas of an assignment's worth? Metacognition is thinking reflectively about learning, and thinking about learning raises questions of truth, trust, openness, intrinsic worth, and even about how one ought to spend one's time. To the extent that metacognition is constrained to levels of considering how one solved a problem or how much time it took is better than no reflection at all. But to limit metacognition to that depth diminishes the spirit of the idea. Surely a teacher who seeks to have students practice reflective thought must model it and value it for what it truly is, an on-going reciprocal self- and shared-assessment of all participants' growth, including that of the teacher.

The very idea of subjecting reflective thought to the limited scope of test preparation is to degrade its most fundamental intent, that of seeking insight and wisdom. Our conclusion is that, sadly, most efforts to provide time for students to reflect on what they have learned through what Bruner has called "bare exposure" represent little more than memory work or skills practice. Very little attention has been paid to the kind of metacognition and reflective thought that might lead to student perceptions of what is true, beautiful, honourable, and worthwhile.

What is ironically and unwittingly labelled "student voice" in the name of reflection, is scarcely that, particularly when one notes that students, the recipients of all the test making, are themselves the test takers. As standardized tests become ever better at what they measure, the question remains whether they take into account those things best measured. The great advocate of reflective thinking, John Dewey (1916), famously wrote more than a century ago that schools will improve when teachers become learners and learners become teachers. That was good advice then, and it is good advice now.

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